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Mobile Surgical Table with Automatic Solenoid System for Fishery Applications

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Mobile Surgical Table with Automatic Solenoid System for Fishery Applications

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ABSTRACT: A self-contained, mobile surgical table for fishery applications is described. An automatic solenoid switching system provides for controlled delivery of anesthetic and anesthetic-free water.

Surgical tables are used extensively for studies on fish physiology and toxicology. They are particularly valuable for preparing fish for in-depth pharmacodynamic studies, which involve analyses of the movement of toxics across biological membranes and the in vivo sampling of blood, bile, urine, and feces (Schmidt and Weber 1973; Hunn and Allen 1974; Gingerich et al. 1978; Kobayashi and Nakamura 1979; Meyerhoff 1980; Schmidt and Kimerle 1981; McKim and Goeden, in press).

New analytical techniques, which require smaller samples and yet provide increased sensitivity, have also helped to stimulate interest in pharmacodynamic studies with fish, resulting in more extensive surgical manipulations. The basic design for the first fish surgical table was described by Smith and Bell (1967), and various modifications of this version are now in use.

The present report describes a self-contained mobile surgical table for fishery applications with an automatic, solenoid valve system for controlled delivery of anesthetic and anesthetic-free water.

Design and Construction

The complete design of this surgical table is presented in two figures. Components of the table design including surgical sling, catch basin and drain, removable top, oxygen delivery system, reservoir tanks, temperature control, and cabinet construction details are shown in Fig. 1; details of the water delivery system, the surgical sling, and the solenoid switching system are shown in Fig. 2, which includes the necessary wiring diagrams for switches, pumps, and solenoids. A complete parts list is available from the authors on request.

Discussion

We describe a mobile, self-contained surgical table that provides an automatic solenoid switching system for fingertip control of anesthetic and anesthetic-free water for fishery studies.

A set of four switches controls the water delivery system and eliminates the need for manual valves and clamps. Two of the switches control the pumps in each of the reservoirs (anesthetic and nonanesthetic), and the other two operate the solenoid drain system (Figs. 1, 2) which consists of two normally closed Valcor solenoid valves, 30 psi, with 1.27-cm (0.5-in.) fittings (Valcor Engineering Corporation, Kenilworth, New Jersey). When the anesthetic pump is on, the solenoid allowing water to return from the catch basin to the anesthetic reservoir is also on; this relation is reversed when the anesthetic-free water is desired. A cleanable in-line glass-wool filter, positioned between the pump and the one-way valves in the water delivery system, removes particulate material that might interfere with the operation of the one-way valves or the needle valve. The automatic solenoid system and water delivery system described here can also easily be added to surgical tables of earlier design.

During surgery, pure oxygen is bubbled slowly into the water in both reservoirs. This is necessary to keep the fish's blood saturated with oxygen (especially in fish larger than 400 g; Smith and Bell 1967), because fish gills collapse when out of water and are therefore not efficient at obtaining oxygen (Davis and Cameron 1971). The use of pure oxygen and the maintenance of low reservoir temperatures (7–10°C) during surgery enabled us to keep rainbow trout (*Salmo gairdneri*) and brook trout (*Salvelinus fontinalis*) from 500 to 1,000 g on the surgical table for 1–2 h with no observed physiological effects.

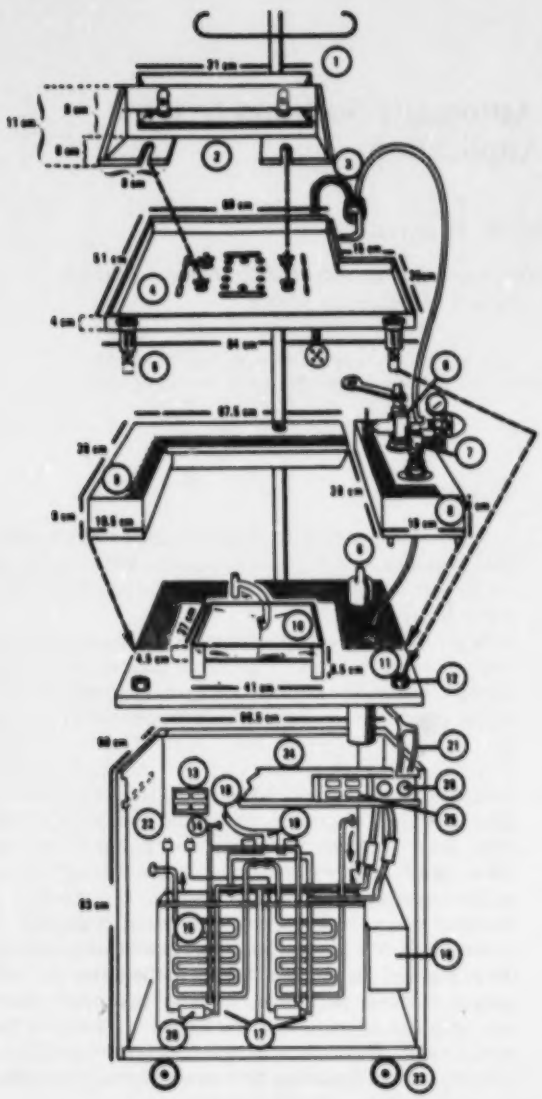

Fig. 1. Overall schematic of fish surgical table, including dimensions. 1, Flexaframe saline hanger; 2, surgical sling (see detail, Fig. 2a); 3, flexible metal arm with gill irrigator; 4, removable acrylic top with drain holes and wingnuts for surgical sling; 5, adjustable pipe leg of polyvinyl chloride (PVC); 6, oxygen tank and regulator; 7, adjustable needle valve (0.64 cm) for water delivery system; 8, removable O_2 tank cover and acrylic top support; 9, acrylic top support; 10, acrylic catch basin and drain; 11, formica cabinet top; 12, adjustable leg hole; 13, four-outlet junction box for pumps, solenoids, and switches (see Fig. 2b wiring diagram); 14, oxygen line from oxygen tank and regulator to reservoir tanks; 15, stainless steel temperature coil (0.95 x 1066.8 cm) attached to temperature mixing valve (Eastman Kodak, N.Y.); 16, shelf for oxygen tank; 17, reservoir tanks for anesthetic and anesthetic-free water (114 L); 18, drain line from catch basin; 19, automatic solenoid system (see detail, Fig. 2c); 20, submersible magnetic drive water pump; 21, water delivery system (see detail, Fig. 2d); 22, plywood cabinet; 23, casters; 24, shelf; 25, switches for pumps and solenoids (see Fig. 2b wiring diagram); 26, indicator lights (see Fig. 2b wiring diagram).

Reservoir water temperatures can be controlled over a wide range by using the temperature coils as heat exchangers in each reservoir. The proper water temperature moving through the coils is maintained by a temperature mixing valve, which mixes hot and cold water just as most shower fixtures do. This arrangement enables selection and maintenance of the desired temperature without the use of ice or special heating or cooling devices. The water source for cooling can be tap water, since the water flowing through the temperature coils has no direct contact with the reservoir water. In addition, each of the reservoirs has a capacity of 113.6 L (30 gal), which eliminates the need to continually renew the anesthetic bath during use because of loss of anesthetic potency or contamination with small amounts of blood and mucus.

The flexible metal arm to which the gill irrigator is attached enables rapid positioning of anesthetic flow through the gill slits or into the mouth without using valves or clamps. A 1.27-cm OD glass U-tube with short (7.6-cm) sections of soft rubber tubing attached is used to spread the water over the gills when the flow is directed anteriorly through the gill slits. The flow rate of anesthetic or anesthetic-free water over the gills is easily controlled by the needle valve assembly without damage to the magnetic drive pumps.

The large work area around the surgical sling makes room for necessary equipment and work space. The design of the table also allows investigators to work from both sides of the table, either for observation or as part of the surgical manipulation. The surgical sling is adjustable for fish of different sizes and can easily be removed and replaced by a larger or smaller sling, depending on fish species and size.

A jaw retractor, to hold the fish's mouth open during work inside the buccal cavity, consists of a blunt hook attached by a nylon cord to a flexaframe rod. The rod is attached at right angles to the flexaframe saline hanger. A small blunt wire hook is fastened to the removable acrylic top at a position directly under the tip of the fish's snout.

For the necessary information on anesthetics and surgical techniques available for cold-blooded vertebrates, we suggest the articles by Smith and Bell (1967), Klontz and Smith (1968), and Randall and Hoar (1971).

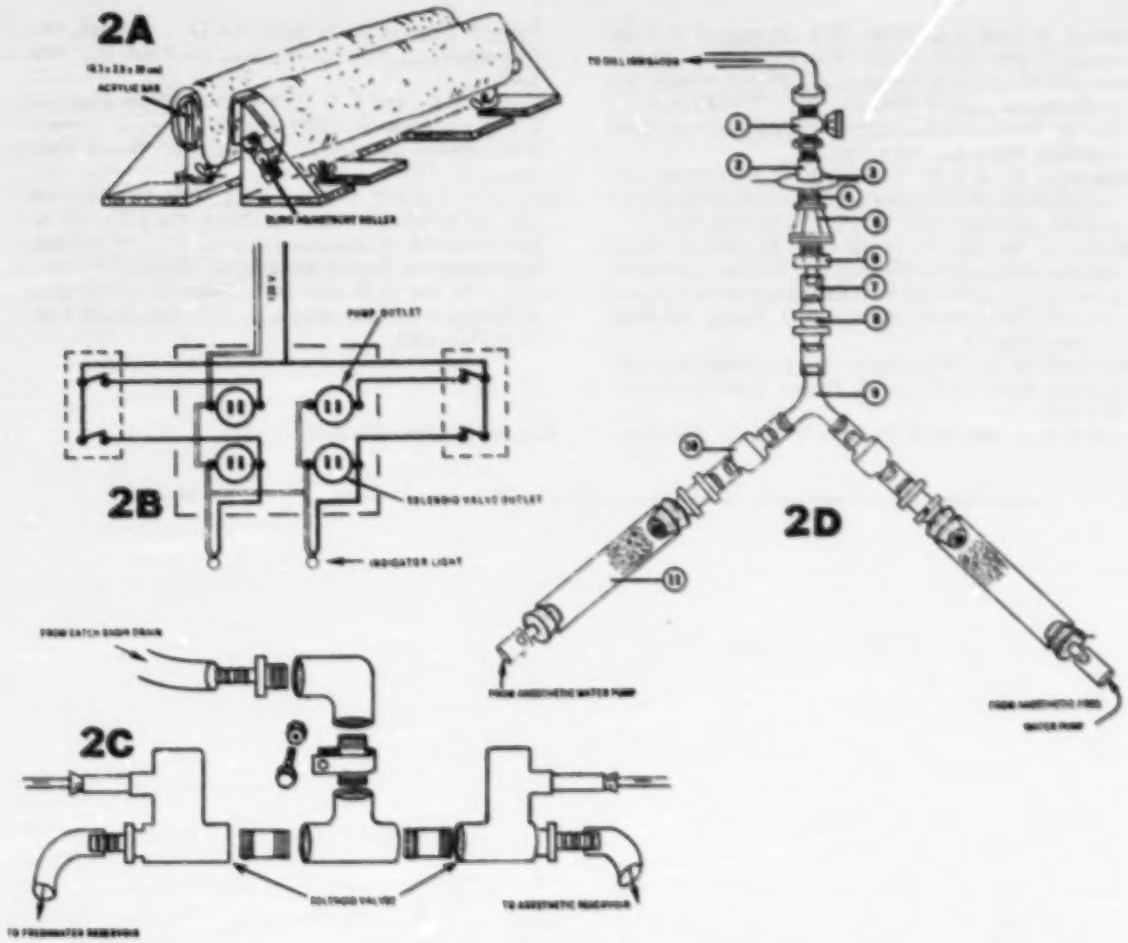

Fig. 2. (A) Detail of surgical sling. The acrylic bar is held in place by two Hoffman screw-type pinchcocks shown in Fig. 1. (B) Wiring diagram for switches, pumps and solenoids. (C) Detail of automatic solenoid system, including placement of normally closed solenoid valves and PVC pipe connections (0.127 cm; 0.05 in.). (D) Detailed schematic of water delivery system: (1) stainless steel needle valve, 0.64 cm (0.25 in.); (2) PVC reducer bushing from 0.95 cm (0.38 in.) to 0.64 cm; (3) table-top pipe flange; (4) PVC nipple, 0.95 cm; (5) PVC reducer coupling from 1.27 cm (05 in.) to 0.95 cm; (6) polyethylene tubing adapter from 1.27-cm pipe to 1.27-cm ID tubing; (7) Tygon tubing, 1.27 cm; (8) quick-connect polyethylene tubing connector, from 1.0 to 1.2 cm (0.39 to 0.47 in.); (9) Y-type polypropylene connector 0.48 cm (0.19 in.); (10) tapered-stem plastic check valves for tubing from 0.95 to 0.64 cm ID; (11) in-line glass-wool filters 2.54 cm O.D. 10.2 cm long (1 x 4 in.).

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